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St. Marys River

St. Marys River - Little Rapids Cut Ice Boom
Winter of 1982-83

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US Army Corps
of Engineers
Detroit District

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THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM
WINTER 1982-1983

BY

U.S. ARMY ENGINEER DISTRICT, DETROIT
DETROIT, MICHIGAN

OCTOBER 1983

TABLE OF CONTENTS

	<u>PAGE</u>
INTRODUCTION	1
AUTHORITY AND PURPOSE	1
WINTER SYNOPSIS	3
ACTIVITIES RELATED TO ICE BOOM OPERATION	5
DATA ANALYSIS	6
CONCLUSIONS	16
RECOMMENDATIONS	16
APPENDIX A: Inventory of Ice through the Little Rapids Cut Ice Boom and Other Boom Events, 1982-1983 Season.	17
APPENDIX B: Aerial Photo Summary, Vicinity of Soo Harbor and Little Rapids Cut, Winter 1982-1983	29
APPENDIX C: Ice Thickness Measurements on the St. Marys River, Winter 1968-1969 to Present.	33

LIST OF TABLES

<u>TABLE</u>		<u>PAGE</u>
1	Average Air Temperatures Sault Ste. Marie Michigan	4
2	Average Ice Thickness at Selected Sites, for Selected Periods	15



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TABLE OF CONTENTS (Cont.)

LIST OF FIGURES

<u>FIGURE</u>		<u>PAGE</u>
1	Location of Little Rapids Cut Ice Boom and Ice Stabilization Islands	2
2	Location of Ice Measuring Stations	7
3	Location of Water Level Gage Stations	8
4	Average Pre- and Postboom Levels at Selected Gate Sites on the St. Marys River	10
5	Average Pre- and Postboom Levels, Lakes Superior and Michigan-Huron	11
6	Average Quarter Month Levels Recorded at Selected Gage Sites for Preboom and Postboom Winter Seasons	12
7	Average Quarter Month Levels Recorded at Selected Gage Sites for the 1982-1983 Winter Season	13

THE ST. MARYS RIVER - LITTLE RAPIDS CUT ICE BOOM
Winter of 1982-1983

INTRODUCTION

The St. Marys River has always been considered one of the key links in the Great Lakes-St. Lawrence Seaway transportation system. Both the United States and Canadian governments have made considerable investments to insure safe and economic transportation of goods and materials through the St. Marys River, especially in the Sault Ste. Marie area. To this end, five navigation locks were built to traverse approximately 20 feet of fall at the St. Marys Rapids, and a 600 foot wide channel, Little Rapids Cut, was excavated in the lower river between Sugar Island and the mainland of Michigan.

Prior to the winter of 1975-1976, experience had shown that winter ship traffic caused broken ice to enter Little Rapids Cut from the harbor at Sault Ste. Marie (Soo), Michigan and Ontario. Periodically, these ice floes would hinder ferry operations between Sugar Island and the Mainland. This broken ice also tended to build-up in the Cut, blocking the navigation channel and further increasing the retardation effects of the normal ice cover.

To help moderate these problems, stabilize the ice cover in the harbor and to act as an aid to winter navigation, an ice boom with a 250 foot wide navigation opening was installed, for the winter of 1975-1976 at the outlet of Soo Harbor. Because of its proven effectiveness this boom continues to be deployed each winter. The location of the ice boom is shown in Figure 1.

AUTHORITY AND PURPOSE

The Little Rapids Cut ice boom was first installed as part of the Great Lakes-St. Lawrence Seaway Navigation Season Extension Program. This program ended after the 1978-1979 winter season. Since the boom provided utility independent of winter navigation, a decision was made to reinstall the system each winter, for an indefinite period. Authority was given to the Soo Area Office, Detroit District, Corps of Engineers to make the installation a part of its regular winter operations.

The St. Marys River ice boom is intended to stabilize the ice cover in Soo Harbor, and to reduce the quantity of brash ice flowing past the Sugar Island ferry crossing into Little Rapids Cut. This report documents the field observation program. Also reported is an analysis to evaluate the effectiveness of the ice boom and to assess any possible effect on water levels.

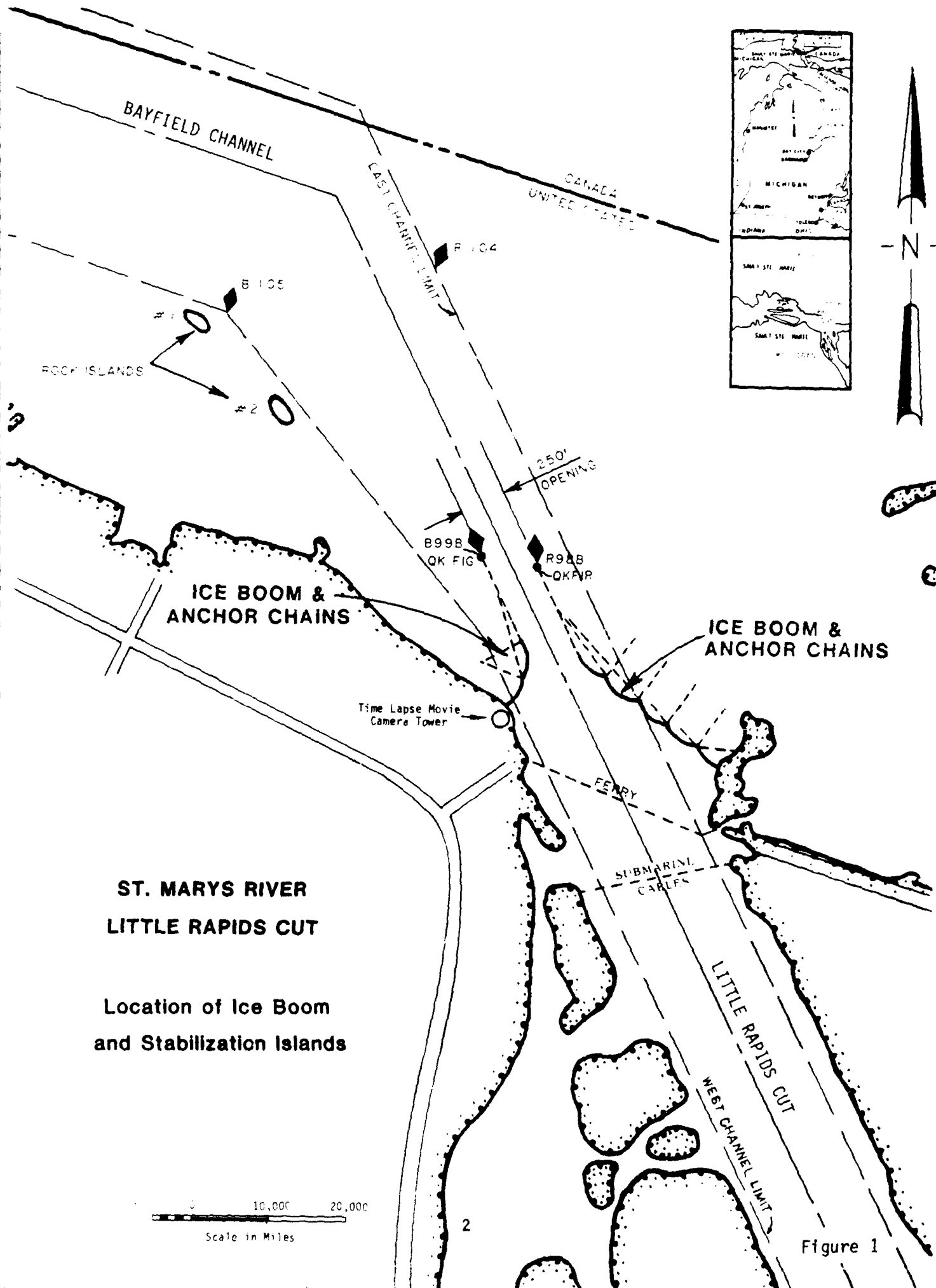


Figure 1

WINTER SYNOPSIS

The east and west arms of the floating timber ice boom at the head of the Little Rapids Cut were installed on 8-10 November and 30 November - 1 December 1982, respectively. The boom's configuration and location are shown in Figure 1. Positioned just upstream of the Sugar Island ferry crossing, the boom is composed of a west arm, which extends 400 feet out from the mainland, and a longer east arm which extends from Mouse Island about 1,000 feet into the river. Mouse Island is a small island just upstream of the Sugar Island ferry slip on the east shore of Little Rapids Cut. The configuration of the boom provides a 250 foot opening in the center of the navigation channel for ship passage.

The locks officially closed to traffic on 27 December 1982. At this time, all the lock approaches and Soo Harbor were ice-free.

On 29 December 1982, ice began forming along the shore of Soo Harbor and in the lock approaches. Ice did not form behind the boom until 12-13 January 1983. By this time the lock approaches were completely frozen over, but Soo Harbor remained generally free of ice.

Mid-January 1983 was the coldest period of the winter. Temperatures averaged below zero during four consecutive days (16-19 January) and the coldest temperature of the winter was recorded on 19 January. By the end of this period the ice cover behind the east boom arm was 80 to 95% complete, and the Lake Nicolet ice field had formed in Little Rapids Cut, to within two miles of the Sugar Island ferry crossing. Despite the cold temperatures, the area behind the west boom was only about 10 to 20% ice covered and Soo Harbor was only about 25% covered.

Although February 1983 was the second warmest February recorded in the last 30 years, with temperatures averaging 6.7 degrees above normal (see Table 1), the temperatures for the first 12 days averaged 3.1 degrees below normal. It was during this period that Soo Harbor gained its most extensive ice cover (approximately 80% covered). This situation did not last long, for during the next 11 days temperatures averaged 32°F. This warm spell caused the ice cover to melt and breakup. By the end of February, Soo Harbor was essentially ice free. The ice field in Lake Nicolet was 5 miles below the Sugar Island ferry crossing and the boom was essentially only holding drift ice from upstream.

Through the month of March the ice boom temporarily restrained varying amounts of brash ice and ice floes from the breakup of the ice field in Lake Superior and the upper St. Marys River. Prior to the opening of the

TABLE 1
AVERAGE AIR TEMPERATURE
SAULT STE. MARIE, MICHIGAN
(°F)

Year	December	January	February	March	April	Winter Average (Dec-Apr) (Jan-Mar)	
1968-69	18.3	15.4	18.3	23.0	38.0	22.6	18.9
1969-70	19.6	9.7	10.2	20.2	39.0	19.7	13.4
1970-71	17.3	9.5	13.1	20.3	35.8	19.2	14.3
1971-72	22.0	13.8	10.7	19.0	33.9	19.9	14.5
1972-73	18.7	19.2	14.6	35.0	39.8	25.5	22.9
1973-74	19.3	14.3	9.6	21.9	37.9	20.6	15.3
1974-75	24.1	16.2	17.9	20.9	32.5	22.3	18.3
1975-76	19.8	10.4	18.8	22.9	40.0	22.4	17.4
1976-77	9.4	5.3	14.3	28.6	40.0	19.5	16.1
1977-78	19.8	10.8	11.1	20.4	35.1	19.4	14.1
1978-79	17.9	8.9	5.2	27.1	37.0	19.2	13.7
1979-80	24.0	15.0	12.4	22.5	41.1	23.0	16.6
1980-81	12.8	8.8	18.6	27.2	39.3	21.3	18.2
1981-82	21.7	4.7	11.5	21.6	31.7	18.2	12.6
1982-83	24.3	15.9	21.0	27.5	37.0	25.1	21.5
15-year average	19.3	11.9	13.8	23.9	37.2	21.2	16.4
National Weather Service 30-year Average	20.1	13.3	14.3	23.9	38.2	-	-
Preboom Average (Dec. 1968-Mar. 1975)	19.9	14.0	13.5	22.9	37.1	21.5	16.8
Postboom Average (Dec. 1975-Mar. 1982)	18.7	10.0	14.1	24.7	37.3	20.8	16.3

navigation season, on 29 March 1983, there was still ice in the locks and the lock approaches. This began to clear out as ships began passing through.

The west boom arm was removed on 5 April. At this time no ice was being held by either arm. The east boom was removed on 11 April.

Because of a mild fall, it was not necessary to set the winter flow at the beginning of December. As a result, gate closures, from a starting condition of 16 gates open in the compensating works, were not effected until mid-December, and were not completed until about mid-January. This, along with the Lake Superior Board's decision to eliminate storage on Lake Superior and the commissioning of the new hydropower plant of Great Lakes Power Limited, resulted in winter flows ranging from about 99,000 cfs to 81,000 cfs. This equates to a winter (December 1982 to April 1983) average flow of about 87,000 cfs, just slightly about the prescribed winter maximum of 85,000 cfs. The combination of mild temperatures and high flows in the St. Marys River explain the general lack of a solid, stable ice cover in Soo Harbor.

ACTIVITIES RELATED TO ICE BOOM OPERATION

The effect of the Little Rapids Cut ice boom on water level and flow patterns in the Soo Harbor and Little Rapids Cut area has been investigated and monitored by the Corps of Engineers each winter since its initial deployment in December 1975. Up until the end of the 1978-1979 winter season, these investigations were a part of the Great Lakes-St. Lawrence Seaway Navigation Season Extension Program. Monitoring continued after conclusion of the program as part of the operation and maintenance of the boom. The monitoring program for the winter of 1982-1983 was patterned after the procedures used in prior years.

Continuous daylight observations of ice conditions in Soo Harbor and Little Rapids Cut were monitored using three time-lapse, super-8mm, movie cameras, recording approximately one frame per minute. Two cameras were installed in the U.S. Coast Guard observation tower at Mission Point, located at the head of the Little Rapids Cut on the Michigan mainland, as shown in Figure 1. Camera No 1 was positioned to record ice conditions at the Sugar Island ferry crossing and downstream in the Little Rapids Cut. Camera No. 2 monitored the ice boom passageway, including the outer end of each boom arm. Both cameras were in operation during the daylight hours from mid-December through mid-April. A third camera was installed in the Administration Building of the Soo Locks to record the movement of vessels through the locks and the effect on the ice cover. Camera No. 3 was positioned in mid-December 1982 to monitor the east or downstream approach to the Poe Lock. This camera was repositioned in late March to cover the upstream approach and was removed in mid-April 1983.

The time-lapse movies taken in the vicinity of the ice boom were reviewed and used to prepare an appendix to this report entitled, "Appendix A: Inventory of Ice through the Little Rapids Cut Ice Boom and Other Boom Events, 1982-1983 Season." Appendix A, summarizes the daily film record of ice passage through the boom opening, and the stability of the ice cover behind the boom arms. This appendix also gives prevailing meteorologic conditions. The record thus generated by the time-lapse movies is helpful in determining the chronology of ice conditions during the winter.

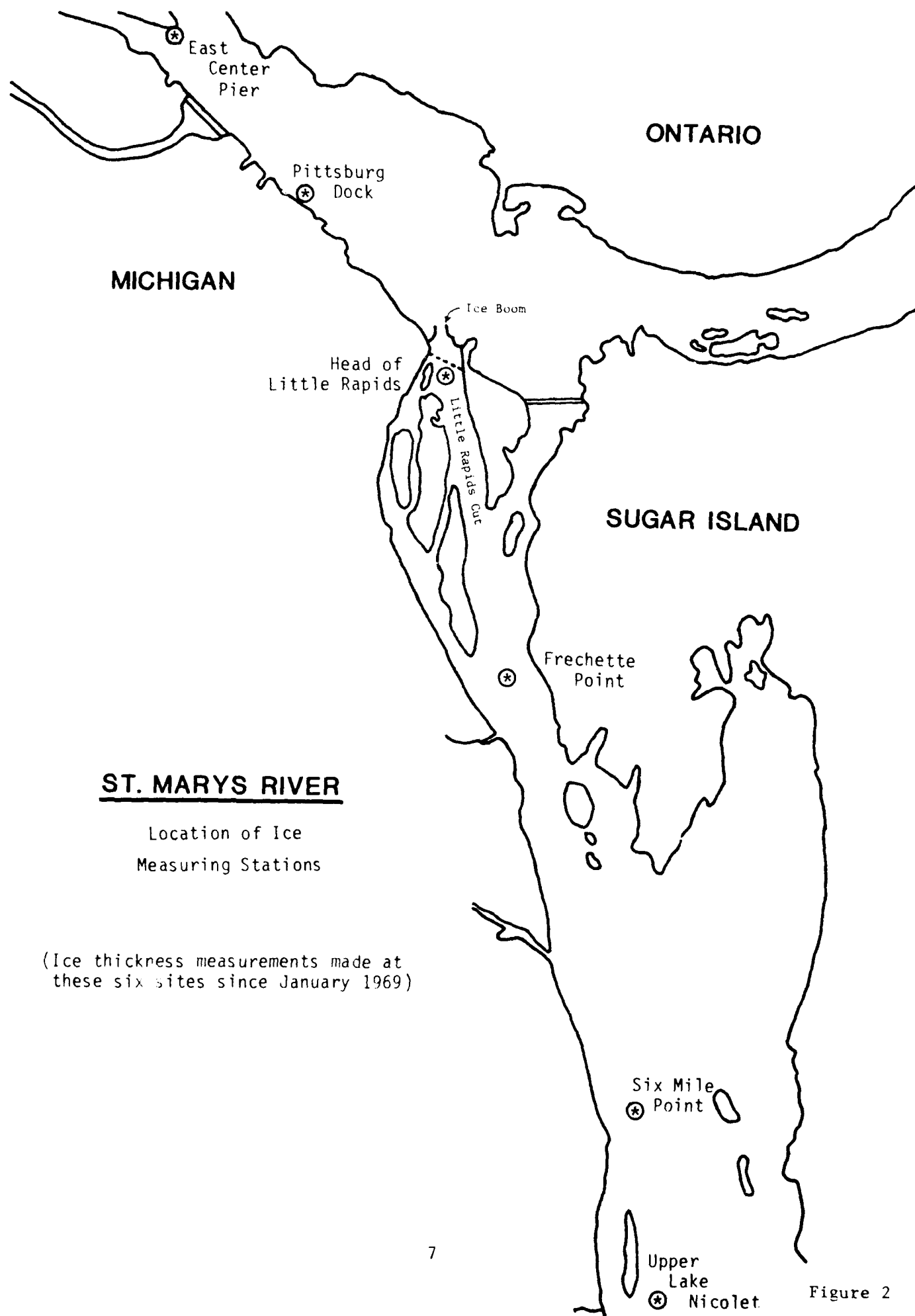
Four sets of low altitude, oblique aerial photographs were made of the entire St. Marys River, between 9 February and 29 March 1983. These photographs yield a more general, over-all view of the ice conditions on the river than do the time-lapse movies. "Appendix B: Aerial Photo Summary, Vicinity of Soo Harbor and Little Rapids Cut, Winter 1982-1983" documents the ice conditions in the area of Soo Harbor and Little Rapids Cut, as seen from the aerial photos.

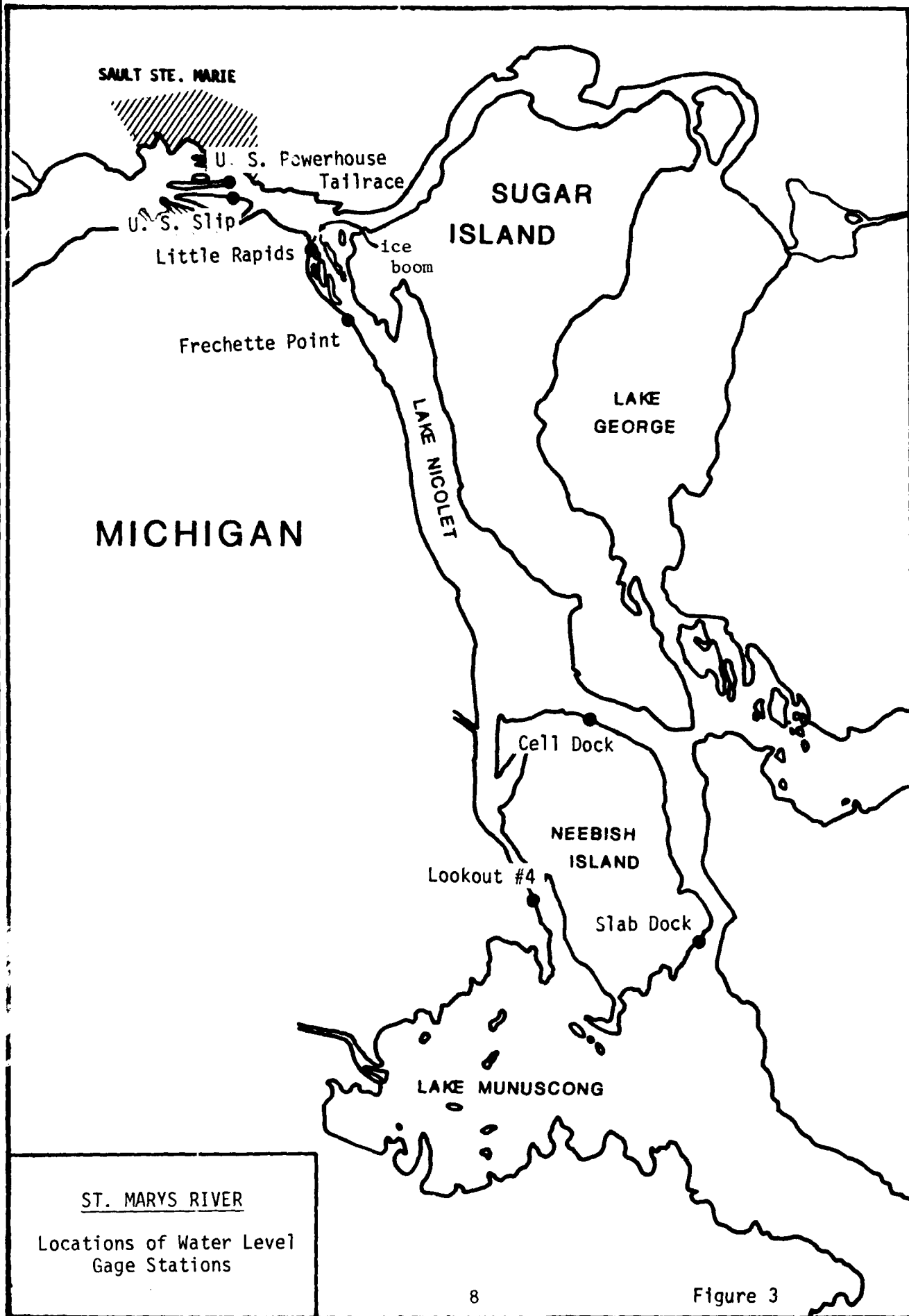
Ice thicknesses above and below the boom were measured at six points along the St. Marys River, as shown in Figure 2. These measurements were made weekly, from 25 January 1983 to 25 March 1983. Appendix B, entitled, "Ice Thickness Measurements on the St. Marys River, Winter of 1968-1969 to Present," gives the data acquired over the last 15 winter seasons on ice thickness and ice characteristics at the six selected stations.

As with previous investigations, some of the data analyzed in this report were acquired in the implementation of the Soo Harbor-Little Rapids Cut Monitoring and Emergency Operations Plan, a program instituted to prevent or reduce flooding in case of an ice jam in the Little Rapids Cut. Throughout the winter season, ice conditions in and around the Soo Harbor-Little Rapids Cut area were visually observed and recorded daily by the Soo Area Office. These records include observations on prevailing and forecasted weather conditions, ice conditions and ship movements throughout the length of the St. Marys River system, as well as icebreaker activities and ferry operations. Also as part of this monitoring plan, the water level gage network in Soo Harbor, Little Rapids Cut and the lower St. Marys River (Figure 3) was closely monitored. The records of the Soo Harbor-Little Rapids Cut Monitoring and Emergency Operations Program may be found in the Great Lakes Hydraulics and Hydrology Branch Archives.

DATA ANALYSIS

To analyze the possible effects of the ice boom on levels and flows, recorded water levels were examined for the period July 1968 to June 1983. The U.S. Slip, Little Rapids and Frechette Point water level gages were chosen for this analysis because of their location relative to the ice boom





(Figure 3). The U.S. Slip gage represents the water levels in Soo Harbor above the boom while the Little Rapids gage records water level data immediately downstream of the boom. The Frechette Point gage records water level data below Little Rapids Cut. These three gages should reflect any effects on water levels and flows that might occur as a result of the ice boom, accumulated ice in Little Rapids Cut or ice in Lake Nicolet.

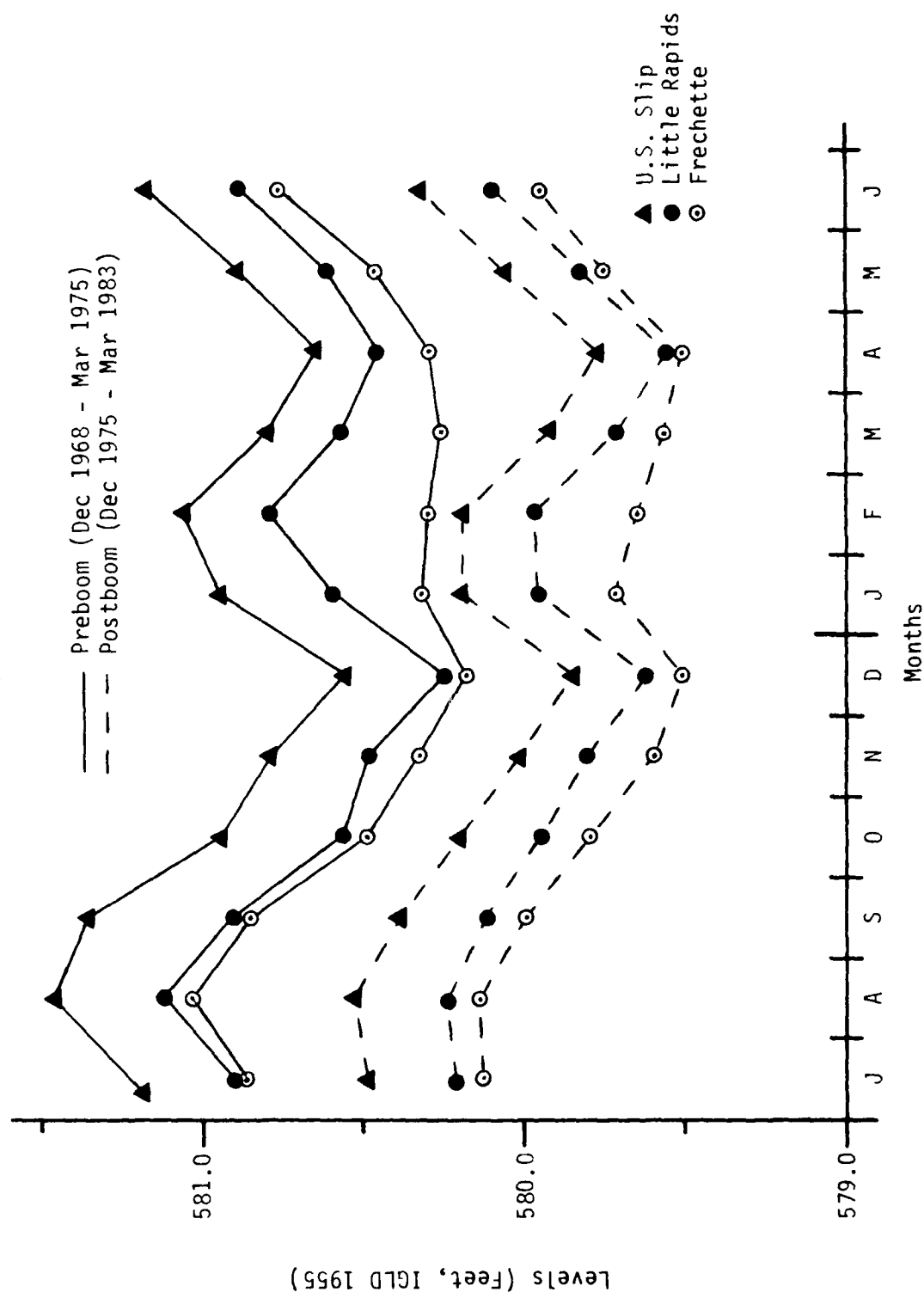
Figure 4 shows plots of actual monthly mean water levels at the three river gages, averaged over two time periods: preboom, July 1968 to June 1975, and postboom, July 1975 to June 1983. Figure 5 shows Lake Superior water levels recorded at Marquette and Lake Michigan-Huron water levels recorded at Harbor Beach, averaged over the same periods. Comparing these two figures, there can be seen a definite rise in the water levels at the selected river gage sites between December and February, which is not reflected in the seasonal fluctuation of the lakes, which show a steady decline into March. The winter rise in levels on the portion of the St. Marys River being reviewed is the result of the retardation of flow by the ice field in Lake Nicolet and Little Rapids Cut. (Flow retardation has the effect of raising water levels upstream of an obstruction (e.g., an ice field) while downstream levels decline). The retardation that is occurring appears to be a natural winter phenomenon in this reach, having occurred during both pre- and postboom winters.

Figure 6 gives a more detailed look at the winter months by showing quarter month average water levels¹ at the U.S. Slip, Little Rapids and Frechette Point gages for pre- and postboom periods. In mid to late December, Figure 6 shows that generally all three gages are beginning to reflect the formation of ice in Lake Nicolet. By mid-January the ice field has usually advanced past Frechette Point and into Little Rapids Cut, as shown by the increased difference between the levels recorded at the Frechette Point and Little Rapids gages. Figure 6 shows no significant difference in the U.S. Slip-Little Rapids relationship between the pre- and postboom periods. This signifies that the ice boom does not retard St. Marys River flow, nor does it affect water levels in the harbor.

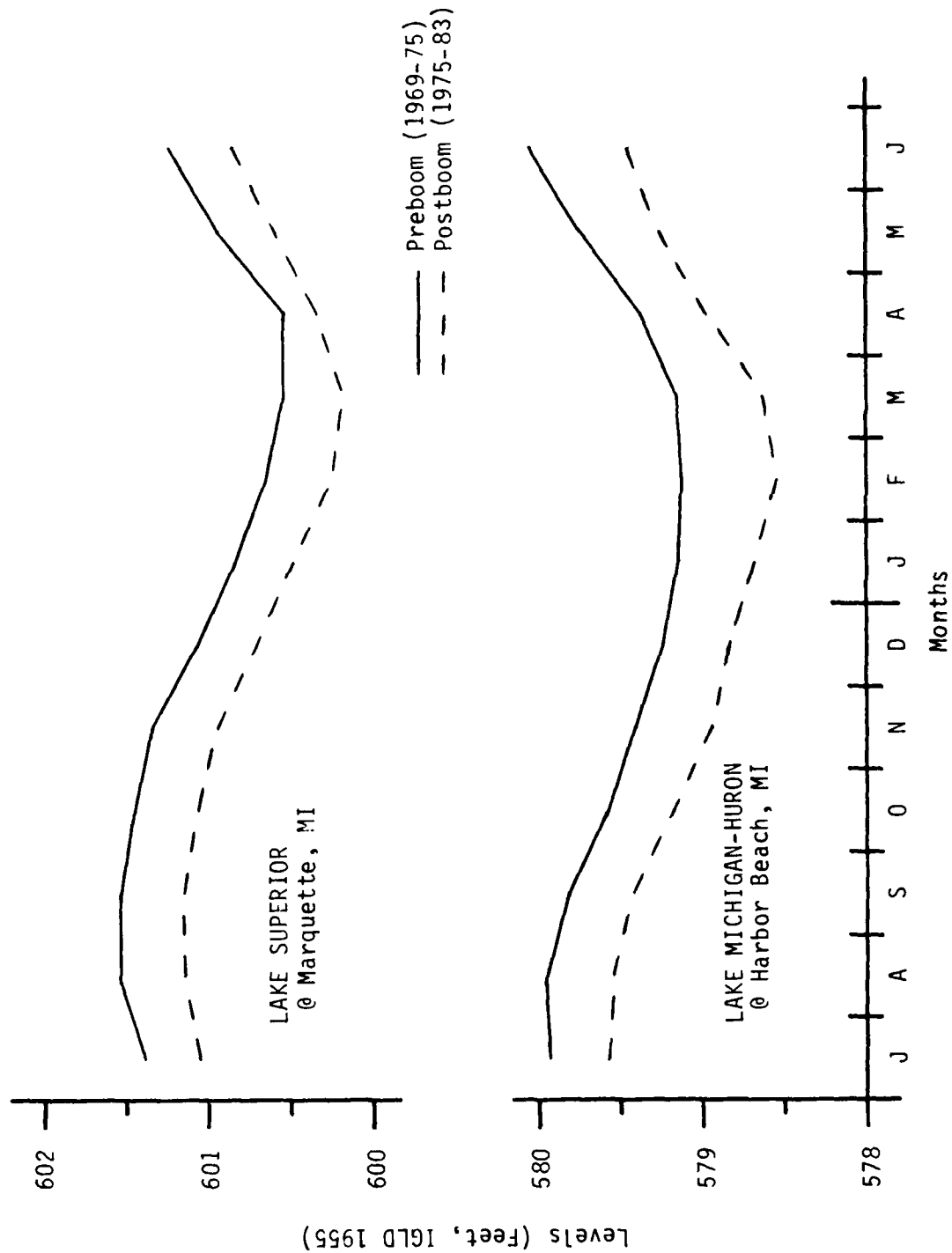
In evaluating the winter of 1982-1983, the water level data for December 1982 through March 1983, for the three river gages, were reviewed. As in past seasons, the gage at Little Rapids was unreliable. Much of the data for the end of December and the first three quarters of January were incomplete or missing. Based on the data available, quarter month average water levels were computed and plotted in Figure 7.

¹Quarter month average water levels were computed by dividing the month into four quarters as follows and meaning the daily levels in each quarter month. Dec, Jan, and Mar: 1-8, 9-15, 16-23 and 24-31; Feb: 1-7, 8-14, 15-21 and 22-28 (22-29 in leap years).

AVERAGE PRE- AND POSTBOOM LEVELS
at Selected Gage Sites
on the St. Marys River



AVERAGE PRE- AND POSTBOOM LEVELS
on Lakes Superior and Michigan-Huron



AVERAGE QUARTER MONTH LEVELS
Recorded at Selected Gage Sites for
Preboom and Postboom Winter Seasons

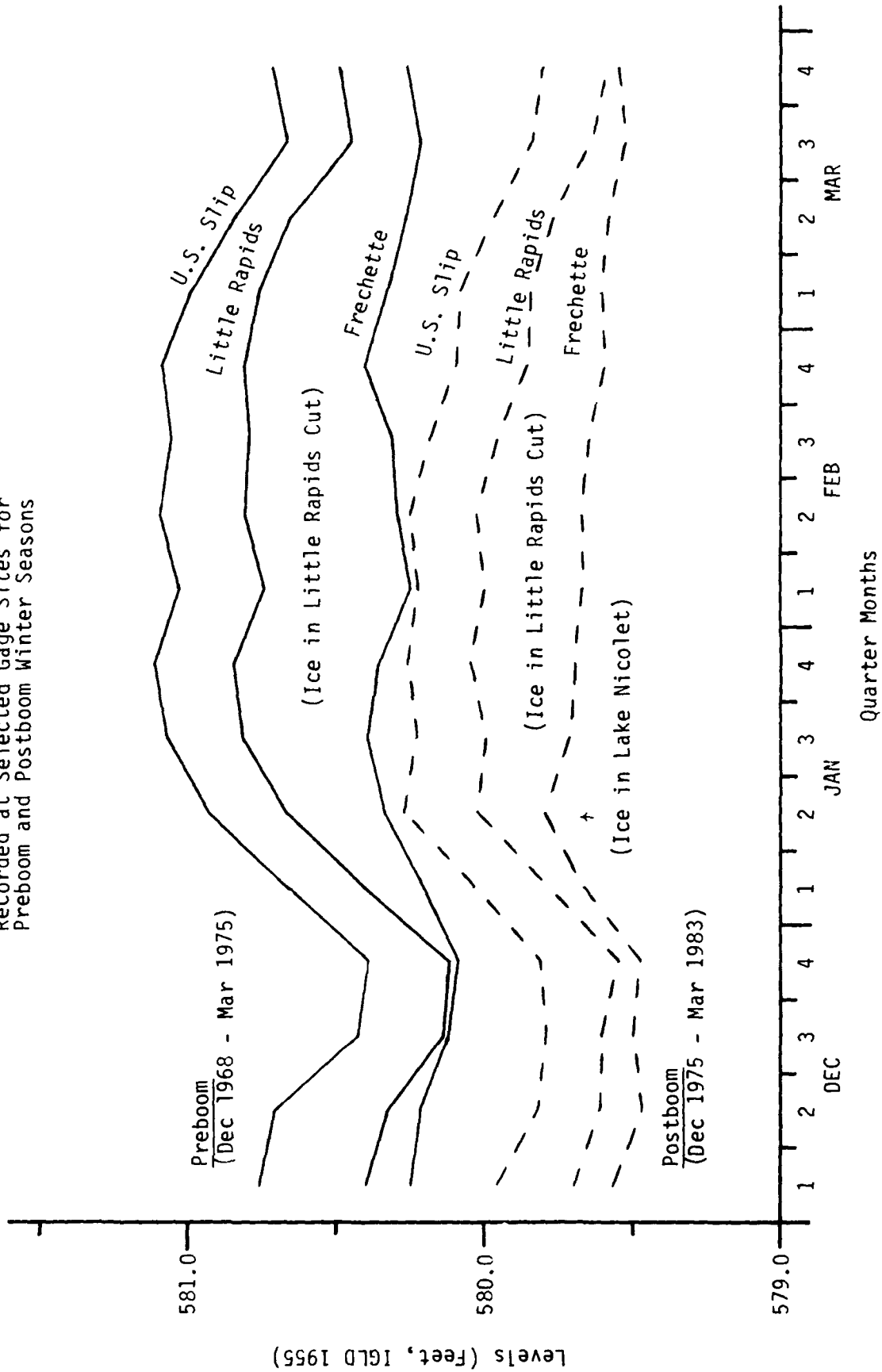


FIGURE 6

AVERAGE QUARTER MONTH LEVELS
Recorded at Selected Gage Sites for
1982-1983 Winter Season

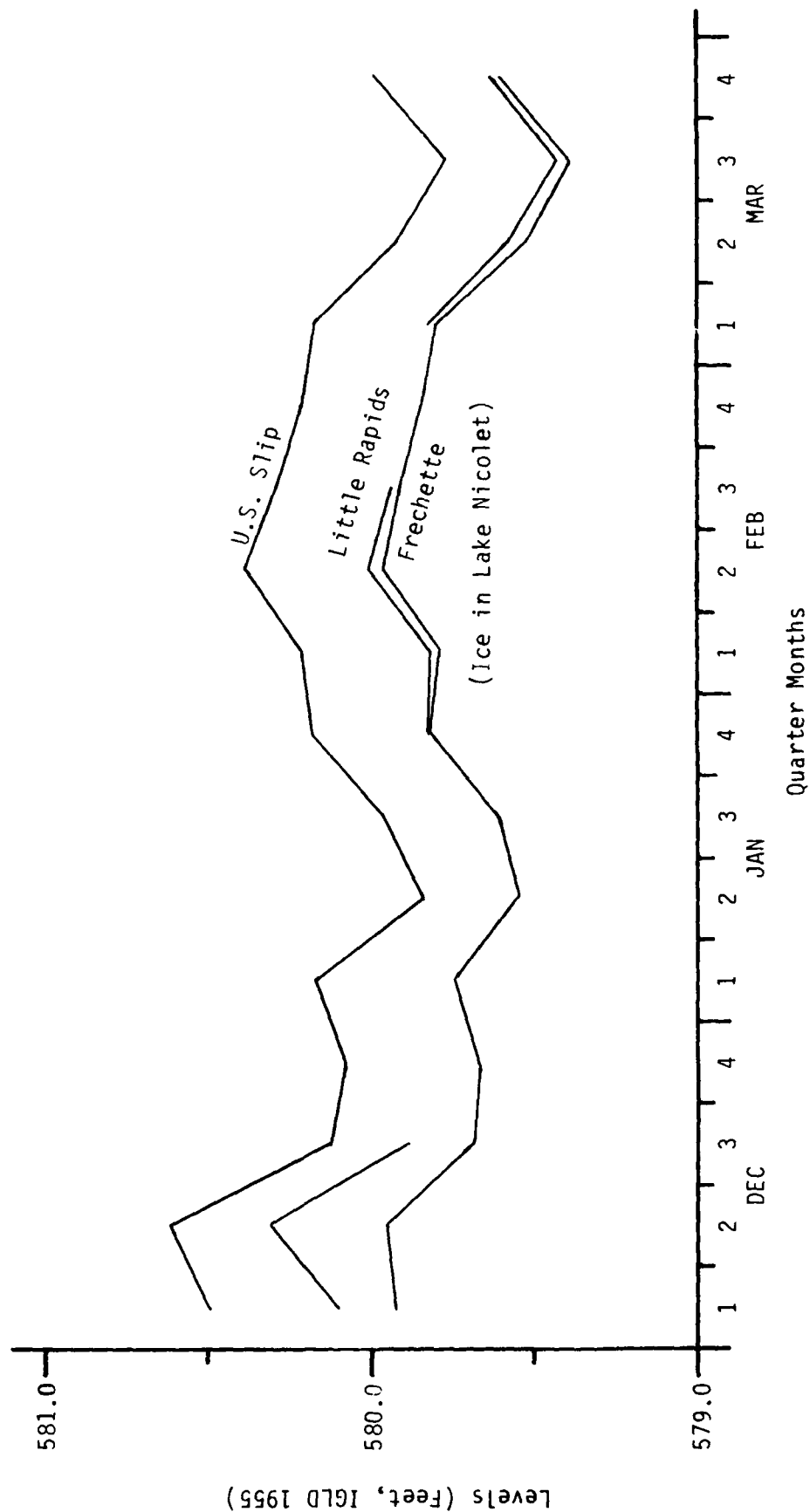


FIGURE 7

The effect of the ice field in Lake Nicolet on the levels is readily seen. By the third quarter of January, ice in Lake Nicolet was within two or three miles of the Sugar Island ferry crossing and flow retardation had begun to cause the levels at all three gages to rise. By mid-February, the Soo Harbor-Little Rapids Cut area had an extensive ice cover, and the flow retarding effect of the ice field below Frechette Point was at its maximum.

In February and March (and perhaps even in January), the water levels recorded at the Little Rapids and Frechette gages were very nearly the same. This was due to the relatively high flow in the river and the ice in Lake Nicolet; not to ice above the Little Rapids gage.

The data in Appendix C were reviewed to determine whether or not the ice boom has had an effect on ice thickness in the river, since its first installation in 1975. The effect of the ice boom and stabilization islands on the ice cover at the head of Little Rapids Cut was readily discernible. Prior to 1975, a solid ice cover at the head of the rapids was common, particularly in February. During the winter that the boom was first installed (1975-1976), the ice cover at the "Head of Little Rapids" measuring site (Figure 2) was too unstable to measure and generally consisted of broken, drifted ice. With the placement of the sunken barge and crane weights during the following winter (these were replaced by permanent rock islands in October 1981), the "Head of Little Rapids" site has had no measurable ice cover. The ice boom and the stabilization islands have tended to stabilize the ice cover above the Cut. This factor, in conjunction with the swift current in Little Rapids Cut, has resulted in the head of the Cut remaining essentially ice free throughout most of the winter.

Any conclusions about the thickness of the ice covers in Soo Harbor and below Little Rapids Cut are less apparent. The thickness of ice is affected by many things. The factors investigated in this analysis are temperature, as recorded at the Sault Ste. Marie, Michigan airport, the presence or absence of the ice boom and whether or not there was winter navigation. Table 2 divides the information from Appendix C into four categories:

- a. Winters with no winter navigation (i.e., no commercial navigation after 31 December) on the river and no ice boom (1969-1970);
- b. Winters with winter navigation and no ice boom (1971-1975);
- c. Winters with winter navigation and the ice boom (1976-1980); and
- d. Winters with the ice boom and no winter navigation (1981-1983).

TABLE 2
AVERAGE ICE THICKNESS, INCHES

MEASUREMENT SITES

	East Center Pier	Pittsburgh Dock	Head of Little Rapids	Frechette Point	Six Mile Point	Lake Nicole	Air Temp. Monthly Ave.
Jan., 2nd Half							Jan
a	8.0	5.8	1.5	6.5	8.5	8.5	12.6
b	0.6*	0.6*	0.8	1.4*	7.9	9.5	14.6
c	2.7*	4.3	0.0	8.0	10.9	11.0	10.1
d	7.0	7.7	0.0	8.2	8.3	11.2	9.8
Feb.							Feb
a	14.5	11.0	11.0	11.5	14.0	14.5	14.2
b	8.0	8.7	6.2	13.0	14.1	22.6	13.2
c	3.9**	6.8	0.0	15.0	16.3	19.7	12.4
d	10.2	10.0	0.0	9.3	12.7	15.2	17.0
Mar., 1st Half							Mar
a	16.2	8.2	1.5	5.2	11.8	15.8	21.6
b	8.2	7.5	3.4*	8.9	14.4	16.6	23.4
c	3.4*	2.6	0.0	14.9	18.2	18.2	24.3
d	8.3	5.0	0.0	3.5	8.2	11.0	25.4
Mar., 2nd Half							
a	4.0	1.0	0.0	1.5	4.0	10.5	
b	7.5**	6.2	1.1*	6.9**	10.1	14.1	
c	0.0	0.0	0.0	2.0*	12.2	15.5	
d	5.3	4.3	0.0	2.3	4.7	8.0	
Average (15 Jan.- 31 Mar.)							Jan-Mar
a	11.4	7.4	5.0	7.2	10.5	12.8	16.1
b	6.5	6.3	3.5	8.6	12.1	17.1	17.1
c	2.8	4.1	0.0	11.0	14.8	16.8	15.6
d	8.2	7.4	0.0	6.5	9.3	12.1	17.4
1983	0.0	0.0	0.0	0.0	2.4	3.2	21.5

a - No ice boom, no winter navigation (1969-1970).

b - No ice boom, winter navigation (1971-1975).

c - Ice boom, winter navigation (1976-1980).
d - Ice boom, no winter navigation (1981-1983).

* = 4 of 5 years were open water, or unsafe cover.

** = 3 of 5 years open water, or unsafe cover.

Above the ice boom, in Soo Harbor, the average ice thickness was greater in years where there was no winter navigation (a,d). During a majority of the winters with winter navigation in the river, there was either open water or an unsafe cover at the East Center Pier site. This was the result of ships breaking up the ice cover as they proceeded into and out of the navigation locks.

Downstream of Little Rapids Cut, the greatest average ice thicknesses occurred during the ice boom/winter navigation (c) period, which was also the period with the coldest average winter temperature of the four periods. The period with the smallest average ice thickness was the ice boom/no winter navigation (d) period. This period had the warmest average winter temperature.

Analysis of the available ice thickness data failed to show any correlation between placement of the ice boom and ice thicknesses in Soo Harbor. An important factor effecting ice thickness in Soo Harbor appears to be winter navigation. The ice boom did have a significant effect on the ice cover at the head of Little Rapids Cut, virtually eliminating it. Further down the Cut, the data is inconclusive, and it appears that neither the boom nor winter navigation is significant.

CONCLUSIONS

The placement of the ice boom and the two permanent rock islands has had no discernible effect on the ice thickness in Soo Harbor and below Little Rapids Cut. There is, also, no indication that the presence of the ice boom has adversely altered the normal retardation of flow caused naturally by ice in Soo Harbor and in and below Little Rapids Cut.

The boom system has been of value in stabilizing the ice cover in Soo Harbor, reducing the extent of ice accumulation in Little Rapids Cut and reducing the amount of ice in the Sugar Island ferry crossing. By reducing the number of ice jams in the Cut, the ice boom has lessened the need for emergency cutbacks in the outflow from Lake Superior, which in the past have caused power losses at the hydropower plants. By reducing the adverse effects of natural ice conditions on the Sugar Island ferry, it has contributed to more reliable winter transportation between Sugar Island and the mainland.

RECOMMENDATIONS

It is recommended that a monitoring program similar to this past season's activities be continued.

APPENDIX A

INVENTORY OF ICE THROUGH THE
ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM
AND OTHER BOOM EVENTS
1981-82 WINTER SEASON

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave.	Min.				
22 Dec	30	25	20	12 E	None	None	Cloudy
23 Dec	35	32	28	27 SE	None	None	Fog in AM, Cloudy
24 Dec	37	36	34	8 E	None	None	Fog in AM, haze PM
25 Dec	47	37	26	26 NW	None	None	Mostly cloudy
5 Jan	34	28	21	15 W	None	None	Cloudy
6 Jan	32	27	21	17 SE	None	None	Mostly cloudy
12 Jan	13	-1	-14	14 NW	East - 15 to 20% West - 75%, thin sheet	Light flow of thin sheets	Clear
19 Jan	9	-5	-18	8 NW	East - 80% cover of broken ice	Moderate flow of large pieces AM, light flow small pieces PM	Weather clear, ice formed between booms
20 Jan	20	8	-5	5 NE	East - 80%, broken ice West - 25%, snow covered AM, accumulated to 100%, broken ice	Heavy flow broken pieces	Partly cloudy, ice between booms broken by ship passage
21 Jan	27	13	-1	9 E	No change	None	Mostly sunny
22 Jan	31	24	17	17 E	No change	None	Rain, snow
23 Jan	32	30	28	14 E	East - 80% snow covered, 20% broken ice West - 40% snow covered, 60% broken ice	Moderate to light flows, large pieces	Mostly cloudy

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave. Min.					
24 Jan	33	31	28	17 NW	East - No change West - 70% broken cover, some downriver flow towards PM	Light flow, large pieces	Cloudy
25 Jan	28	17	5	27 NW	East - 60-70% cover with holes West - 90% cover with holes	Very light flow of small pieces increasing to heavy by PM	Haze in AM, clear by PM
26 Jan	16	7	-2	20 W	East - 40-50% cover West - 90% cover, some break up and downstream flow PM	Light flow of small pieces	Cloudy, snow
27 Jan	18	12	5	15 SW	East - 60-70% cover West - 75% cover with break up and downriver flow to 50% cover	None	Partly sunny
28 Jan	28	19	10	16 SE	East - 60-70% cover West - 50% broken pieces (Additional breakup on both sides)	None	Snow and rain
29 Jan	34	31	28	14 SE	East - 5-10% cover West - 40-50% cover, some breakup	None	Snow
30 Jan	35	33	30	18 W	East - 40-50% broken ice cover West - No change	Very light flow of large sheets	Snow

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms		Ice Passing Into Little Rapids Cut		Other Comments
	Max.	Ave.	Min.						
31 Jan	30	18	5	21 NW	East - No change West - No change		Very light flow of small pieces		Snow
1 Feb	22	10	-2	8 NE	East - No change West - No change		None		Snow
2 Feb	26	21	16	25 NE	East - 65% cover with holes West - 30% solid, 30% broken cover		Moderate flow of thin sheets		Snow
3 Feb	19	12	4	18 NE	East - 100% cover with holes West - 60% cover		None		Snow
4 Feb	8	1	-6	17 NW	East - 90% cover West - 70% broken cover		None		Partly cloudy
5 Feb	19	9	-2	9 E	East - 98% cover with holes West - 80% broken cover		None		Clear
6 Feb	23	20	16	10 NW	East - No change West - 85% cover with holes		Light flow with thin sheets		Snow, Fog PM
7 Feb	20	8	-4	14 NW	East - 100% cover with holes West - 90% cover with holes		None		Fog, clear PM
8 Feb	24	9	-6	9 NE	No change		None		Fog, clear PM
9 Feb	16	6	-5	15 E	No change		None		Clear
10 Feb	10	2	-6	17 SE	No change		None		Clear, snow on ice is melting

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction	Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave. Min.				
11 Feb	19	11	2	17 E	East - 95% cover with holes West - 85% cover, holes widening	None Clear
12 Feb	26	17	8	10 E	East - 100% cover West - 95% cover	None Mostly cloudy, some snow
13 Feb	39	33	26	22 SW	Cracks forming in ice both booms	None Mostly cloudy
14 Feb	36	35	33	13 SW	Cracks and holes widening, both booms	None Cloudy
15 Feb	35	33	31	9 NW	East - 80-90% cover, some breakup West - 75% cover, some breakup and flow downriver	Very light flow of thin pieces Cloudy
16 Feb	32	32	31	13E	East - 50-60% cracked and broken cover West - 75-80% cracked and broken cover	None Snow, rain PM
17 Feb	33	26	19	25 NW	East - 5-10% cover West - 60% cracked and broken cover	Large, thin floes Partly cloudy
18 Feb	34	26	18	13 SE	East - 25-30% cover West - 60-70% broken cover with some downflow	Heavy flow of large pieces, light flow of small pieces PM Cloudy

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (°F)			Maximum Wind Speed (MPH) and Direction	Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave.	Min.				
19 Feb	38	35	32	19 E	East - None West - 25% broken cover with breakup and flow downriver	Light to moderate flow of small thin pieces	Mostly Cloudy
20 Feb	47	39	31	22 NW	East - 5-10% broken cover West - 75% broken cover with some breakup and flow	Moderate flow of small thin pieces	Haze AM, cloudy
21 Feb	36	31	26	17 NW	East - None West - 75-80% broken cover	None	Cloudy
22 Feb	32	29	26	15 SE	East - None West - 85-90% broken cover	Moderate flow of small and medium pieces	Cloudy
23 Feb	33	28	23	22 NW	East - None West - 85% broken cover with holes	Light flow of small pieces	Clear
24 Feb	25	18	10	17 NW	East - None West - 60-70% broken cover with some flow downriver	Light flow of large thin pieces	Mostly cloudy
25 Feb	21	12	2	15 NW	East - None West - 40-50% broken cover with some flow downriver	Moderate flow of small thin pieces	Clear
26 Feb	33	18	3	15 SW	East - 10-15% thin piece cover West - 90-100% thin piece cover	Light flow of small pieces in PM	Cloudy

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave. Min.					
27 Feb	39	33	27	16 SW	East - None West - 70-80% thin, broken cover with some flow downriver	Moderate flow of medium to small pieces	Cloudy
28 Feb	41	37	32	12 SW	East - None West - 10-0% broken cover with downriver flow to none	None	Mostly cloudy
1 Mar	33	31	29	12 NW	None	None	Mostly cloudy, some snow
2 Mar	34	30	25	12 NW	None	None	Cloudy
3 Mar	31	26	20	17 SE	East - 75% broken cover West - 75% broken cover	Heavy flow of large thin sheets PM	Mostly cloudy, snow
4 Mar	36	32	28	18 E	East - 10-20% large broken piece West - 25% large broken piece	Light flow of thin sheets	Cloudy, snow AM
5 Mar	43	38	32	20 SE	East - 5% coverage West - 10-35% coverage of broken piece, with downriver flow	Light flow of small clumped pieces	Mostly cloudy
6 Mar	45	42	38	20 SE	None	None	Mostly cloudy, snow
7 Mar	42	41	39	18 E	None	Very light flow, small pieces	Fog and AM snow

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut		Other Comments
	Max.	Ave. Min.						
8 Mar	41	40	38	15 E	None	Very light flow, small thin sheets	Fog	
9 Mar	40	28	16	17 NE	East - None West - 25% very thin sheet cover	Light flow of thin sheets	Rain, fog	
10 Mar	26	21	15	15 NE	None	None	Cloudy	
11 Mar	37	24	10	17 NW	East - None West - 10-15% thinly broken ice	Very light flow of thin sheets	Clear	
12 Mar	40	29	17	7 N	East - 5% broken cover West - 5% broken cover	Light flow of small pieces	Mostly cloudy	
13 Mar	49	34	18	12 SE	East - 30-40% small broken cover West - 60-70% small broken cover	Heavy flow of small pieces	Clear	
14 Mar	35	32	28	22 NW	None	Light flow of small pieces	Cloudy, fog	
15 Mar	42	34	26	19 NW	East - 80-90% small broken cover West - 10-20% small broken cover	Moderate flow of small pieces	Partly cloudy	

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave. Min.					
16 Mar	36	30	23	7 E	East - 20-30% small broken cover West - 70-80% small broken cover	Moderate flow of small pieces	Mostly cloudy
17 Mar	46	38	30	14 E	East - 20-30% stacked small pieces West - 90% stacked small pieces	Light flow of small pieces	Mostly cloudy
18 Mar	45	38	31	13 E	None	Heavy early flow dissipating to nothing	Partly cloudy
19 Mar	33	24	15	16 N	None	None	Rain, snow, fog
20 Mar	29	20	11	17 NE	None	None	Clear
21 Mar	18	12	6	20 NE	East - 5% accumulation West - 5% accumulation	Light to moderate flow of large very thin sheets	Partly cloudy
22 Mar	20	13	5	21 NW	East - 40-50% broken, snow West - 100% broken, snow covered	Heavy flow of large thin pieces	Mostly cloudy
23 Mar	18	10	2	19 NW	East - 40-50% cover of snow, melting West - 100% cover of snow, melting	Heavy flow of large thin pieces	Clear
24 Mar	22	10	-3	9 NE	East - 50-60% cover with holes West - 100% cover with holes	Very light flow of thin sheets	Clear

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms		Ice Passing Into Little Rapids Cut		Other Comments
	Max.	Ave.	Min.						
25 Mar	31	14	-4	8 SE	East - 40-50% cover West - 80% to 60% cover, downriver flowing	None	None	Clear	
26 Mar	38	25	11	12 E	East - 20-30% cover West - 80% to 15% cover with downriver flow	Moderate flow of thin sheets	Partly cloudy		
27 Mar	38	34	30	20 E	None	None	None	Cloudy	
28 Mar	36	28	20	23 NW	East - 50-60% cover West - 100% small broken cover	Light flow of thin sheets	Clear		
29 Mar	33	21	9	10 NE	East - 40-50% thin cover West - 90% thin cover	Light flow of thin pieces	Clear		
30 Mar	39	29	18	16 SE	East - 5-10% large broken pieces West - 75% large broken pieces	Light flow of large thin pieces	Mostly cloudy		
31 Mar	42	34	25	17 E	None	Very light flow of small thin pieces	Cloudy		
1 Apr	48	35	22	17 SE	East - 30-40% small piece cover West - 80% to 60% small piece cover with flow downriver	Light flow of grouped small pieces	Partly cloudy increased boat passage		

INVENTORY OF ICE THROUGH THE ST. MARYS RIVER-LITTLE RAPIDS CUT ICE BOOM AND OTHER BOOM EVENTS
1982-1983 WINTER SEASON

Date	Air Temperature (F°)		Maximum Wind Speed (MPH) and Direction		Ice Behind Boom Arms	Ice Passing Into Little Rapids Cut	Other Comments
	Max.	Ave. Min.					
2 Apr	52	42	31	30 E	All ice breaks up and flows downriver on both booms	Moderate flow of medium size pieces	Cloudy
3 Apr	43	38	32	27 E	None	None	Cloudy
4 Apr	41	37	33	10 NW	None	Light flow of small thin pieces	Mostly cloudy, rain
5 Apr	44	36	28	16 NW	East - None West - Removed	Very light flow of small pieces	Clear
6 Apr	43	36	29	13 SE	East - None	Very light flow of small pieces	Cloudy
7 Apr	38	36	33	11 W	East - None	None	Cloudy
8 Apr	48	40	31	12 NW	East - 5-10% small pieces cover	Heavy flow of very small pieces	Partly cloudy
9 Apr	51	40	28	31 SE	East - None	None	Mostly cloudy
10 Apr	42	36	30	17 E	East - None	Very light flow of small pieces	AM Fog
11 Apr	44	38	32	13 NW	East - Removed	None	Mostly cloudy
12 Apr	52	39	25	-	-	None	Clear
13 Apr	43	38	32	-	-	None	Haze, rain
14 Apr	53	44	35	-	-	None	Cloudy

APPENDIX B

AERIAL PHOTO SUMMARY
VICINITY OF SOO HARBOR AND LITTLE RAPIDS CUT
WINTER 1982-1983

AERIAL PHOTO SUMMARY
VICINITY OF SOO HARBOR - LITTLE RAPIDS CUT
WINTER 1982-1983

9 February - Soo Harbor was 60% ice covered. The area behind the ice boom was 90-95% ice covered. There was open water from between the boom arms to within one miles of Frechette Point.

25 February - The lock approaches were ice covered. Broken drift ice 75% filled the area above the compensating works. Soo Harbor was generally ice free with some shore ice. The areas behind both boom arms were approximately 15% covered with drift ice.

11 March - The area above the compensating works was clear. The lock approaches were covered with thin ice. Soo Harbor was ice free. There was no ice behind the booms or in Little Rapids Cut.

29 March - Broken drift ice filled the area above the compensating works and lock approaches. The lock approaches themselves, both up- and downstream, were covered with broken ice. Soo Harbor was mainly clear with some shore ice. Drift ice covered about 15% of the area behind the west boom arm. No ice behind the east boom arm. Little Rapids Cut was ice free into Lake Nicolet.

APPENDIX C

ICE THICKNESS MEASUREMENTS
ON THE ST. MARYS RIVER

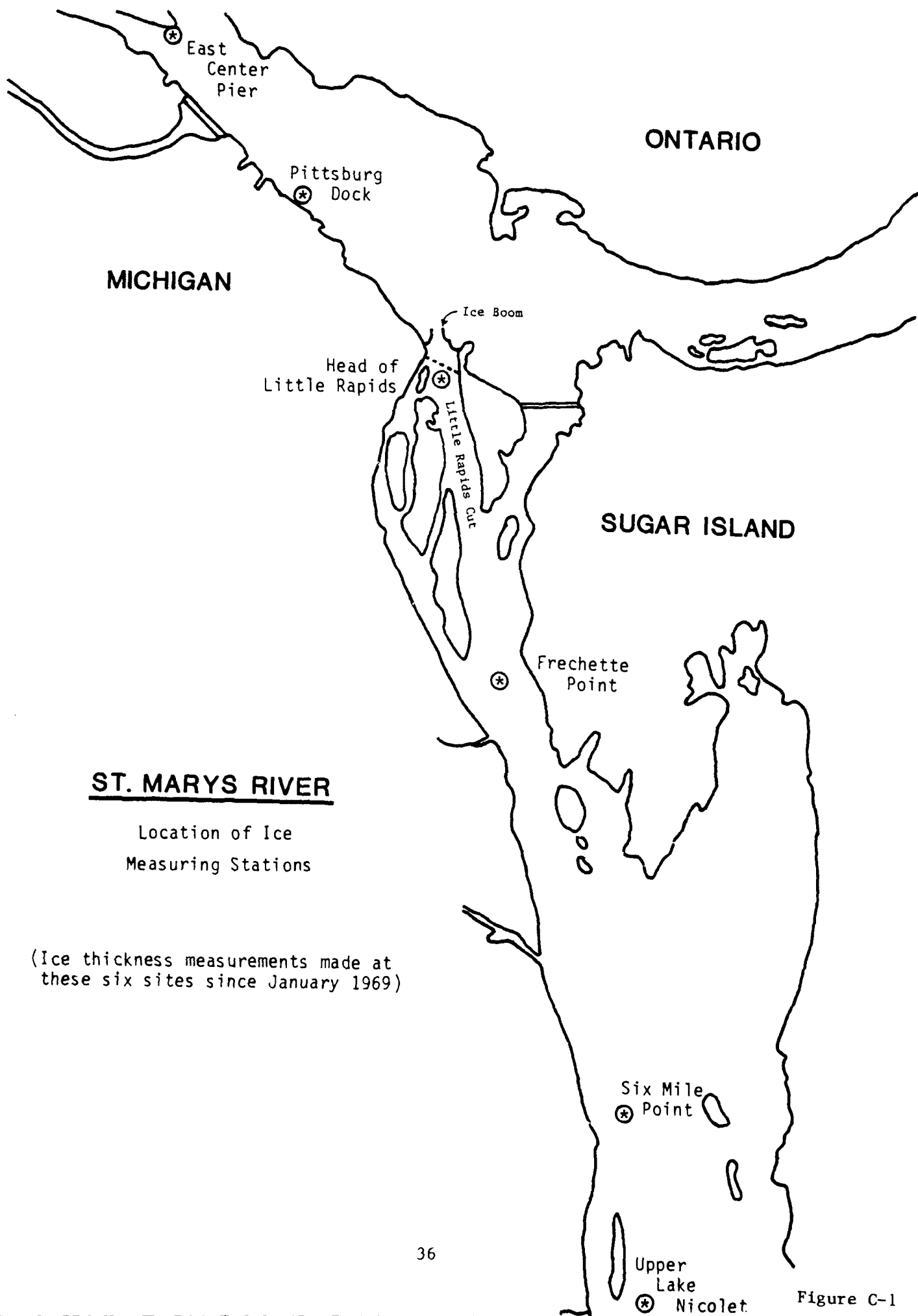
WINTER OF 1968-1969 TO PRESENT

APPENDIX C

Ice Thickness Measurements on the St. Marys River

The ice thickness and characteristic data acquired during the past 15 winter seasons are included in this appendix. The six sites selected for measurements are located adjacent to the navigation channel between the Soo Locks and Lake Nicolet (see Figure C-1). These sites are the same sites where the Regulatory Works Sub-committee of the International Great Lakes Levels Board Working Committee conducted ice thickness and ice characteristic measurements during the winter periods from 1968-1969 through 1971-1972. These measurements were a part of a program to determine the feasibility of operating the Lake Superior Regulatory Works during the winter.¹ The observations continued under the Great Lakes-St. Lawrence Seaway Navigation Season Extension Program in an attempt to determine whether winter ship passage and, later, ice boom placement had an effect on ice thickness. This season, observations were made to maintain a continuous record of the ice season over the last 15 years.

¹Regulatory Works Subcommittee, International Great Lakes Working Committee, "Winter Operations at the Lake Superior Regulatory Works, Sault Ste. Marie, Winter of 1968-1969," and supplements of the same title for "Winter of 1969-1970," and "Winter of 1970-1971."



ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1982-83

Sta.	Location	25 JAN 83	9 FEB 83	15 FEB 83	24 FEB 83	2 MAR 83	3 MAR 83										
1	East Center Pier	U.C.	U.A.	O.W.	O.W.	O.W.	O.W.										
2	Pittsburg Dock	O.W.	U.A.	U.A.	U.A.	O.W.	O.W.										
3	Head of Little Rapids	O.W.	O.W.	U.A.	O.W.	O.W.	O.W.										
4	Frechette Point	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.										
5	Six Mile Point	O.W.	7" 57% B.I.	8" 50% B.I.	U.A.	O.W.	O.W.										
6	Upper Lake Nicolet	U.C.	8" 75% B.I.	6" 67% B.I.	U.A.	O.W.	O.W.										

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI =Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1981-82

Sta.	Location	15 JAN 82	21 JAN 82	29 JAN 82	4 FEB 82	11 FEB 82	18 FEB 82	25 FEB 82	4 MAR 82	11 MAR 82	18 MAR 82	25 MAR 82
1	East Center Pier	9" 67% BI	10" 80% BI	14" 57% BI	16" 62% BI	20" 75% BI	18" 83% BI	17" 82% BI	17" 82% BI	20" 80% BI	21" 76% BI	U.A.
2	Pittsburg Dock	7" 71% BI	9" 44% BI	14" 57% BI	17" 53% BI	20" 60% BI	22" 68% BI	18" 67% BI	15" 60% BI	15" 40% BI	17" 47% BI	U.A.
3	Head of Little Rapids	O.W.	O.W.	U.A.	O.W.	O.W.	U.A.	U.A.	U.A.	U.A.	U.A.	O.W.
4	Frechette Point	8" 50% BI	10" 70% BI	12½" 60% BI	16½" 45% BI	15" 47% BI	16" 44% BI	13" 46% BI	11" 45% BI	10" 30% BI	14" 36% BI	O.W.
5	Six Mile Point	7" 86% BI	12" 58% BI	14" 57% BI	18" 61% BI	17" 65% BI	17" 59% BI	15" 67% BI	16" 56% BI	18" 61% BI	19" 42% BI	U.A.
6	Upper Lake Nicolet	16" 50% BI	15" 53% BI	18" 61% BI	18" 61% BI	22" 55% BI	23½" 57% BI	27" 56% BI	20" 50% BI	19" 58% BI	21" 57% BI	U.A.

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1980-81

Sta.	Location	19 JAN 81	26 JAN 81	2 FEB 81	9 FEB 81	19 FEB 82	26 FEB 81	4 MAR 81	12 MAR 81						
1	East Center Pier	10" 100% B.I.	10½" 100% B.I.	12½" 100% B.I.	13" 100% B.I.	13½" 100% B.I.	11½" 100% B.I.	13" 100% B.I.	O.W.						
2	Pittsburg Dock	13½" 100% B.I.	13" 100% B.I.	14½" 100% B.I.	12½" 100% B.I.	12" 100% B.I.	U.A.	O.W.	O.W.						
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.						
4	Frechette Point	15" 73% B.I.	14" 64% B.I.	15" 53% B.I.	14½" 52% B.I.	12" 25% B.I.	O.W.	O.W.	O.W.						
5	Six Mile Point	14" 64% B.I.	14" 64% B.I.	16" 56% B.I.	17" 53% B.I.	16" 38% B.I.	12" 25% B.I.	U.A.	U.A.						
6	Upper Lake Nicolet	12½" 92% B.I.	14" 93% B.I.	16" 78% B.I.	15" 93% B.I.	17½" 49% B.I.	18½" 65% B.I.	17" 76% B.I.	10" 60% B.I.						

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; B.I. = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1979-80

40

Sta.	Location	18 JAN 80	25 JAN 80	1 FEB 80	8 FEB 80	15 FEB 80	22 FEB 80	29 FEB 80	10 MAR 80	17 MAR 80	21 MAR 80		
1	East Center Pier	O.W.	U.A.	U.A.	U.A.	U.A.	O.W.	U.A.	O.W.	O.W.	O.W.		
2	Pittsburg Dock	O.W.	U.A.	U.A.	U.A.	U.A.	O.W.	O.W.	O.W.	O.W.	O.W.		
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.		
4	Frechette Point	O.W.	U.A.	7" 14% B.I.	3" 100% B.I.	O.W.	O.W.	5" 30% B.I.	O.W.	O.W.	O.W.		
5	Six Mile Point	O.W.	U.A.	10" 70% B.I.	11 1/2" 61% B.I.	11" 73% B.I.	U.A.	7" 29% B.I.	10 1/2" 24% B.I.	U.A.	U.A.		
6	Upper Lake Nicolet	U.A.	10" 100% B.I.	11" 100% B.I.	13 1/2" 100% B.I.	13" 85% B.I.	9" 100% B.I.	11 1/2" 57% B.I.	13" 85% B.I.	9 1/2" 68% B.I.	U.A.		

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI =Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1978-79

41

Sta.	Location	16 JAN 79	23 JAN 79	30 JAN 82	7 FEB 79	14 FEB 79	20 FEB 79	26 FEB 79	6 MAR 79	13 MAR 79	20 MAR 79	27 MAR 79	3 APR 79
1	East Center Pier	U.A.	U.A.	U.A.	U.A.	U.A.	U.A.	U.A.	O.W.	O.W.	O.W.	O.W.	O.W.
2	Pittsburg Dock	U.A.	U.A.	U.A.	13" 38% BI	17" 59% BI	20" 60% BI	18" 44% BI	13" 69%	U.A.	O.W.	O.W.	O.W.
3	Head of Little Rapids	U.A.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	11" 100% BI	11½" 100% BI	11" 55% BI	14" 71% BI	16" 78% BI	17" 65% BI	18½" 65% BI	16" 50% BI	14" 79% BI	O.W.	O.W.	O.W.
5	Six Mile Point	12" 92% BI	12" 75% BI	13" 62% BI	16" 66% BI	21" 81% BI	15" 67% BI	19" 58% BI	15" 80% BI	19" 53% BI	U.A.	U.A.	O.W.
6	Upper Lake Nicolet	13" 77% BI	14" 79% BI	13" 85% BI	15" 83% BI	16" 81% BI	19" 79% BI	18" 72% BI	15" 93% BI	20" 60% BI	16" 62% BI	18" 71% BI	U.A.

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1977-78

42

Sta.	Location	JAN 3, 78	JAN 11, 78	JAN 16, 78	JAN 23, 78	JAN 30, 78	FEB 7, 78	FEB 13, 78	FEB 21, 78	FEB 27, 78	MAR 6, 78	MAR 13, 78	MAR 21, 78
1	East Center Pier	O.W.	O.W.	U.A. U.C.	U.A. U.C.	U.A. O.W.	U.A. U.C.	U.A. U.C.	U.A. O.W.	U.A. O.W.	O.W.	O.W.	O.W.
2	Pittsburg Dock	O.W.	O.W.	U.A. U.C.	U.A. U.C.	17" 94% BI	12" 98% BI	13½" 89% BI	14½" 90% BI	12" 92% BI	13" 100% BI	U.A.	O.W.
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	U.A. O.W.	O.W.	U.A. O.W.	U.A. O.W.	U.A.	U.A. O.W.	U.A. O.W.	O.W.
4	Frechette Point	O.W.	O.W.	U.A. U.C.	U.A. U.C.	16½" 100% SN	20" 94% SN	21½" 72% SN	21" 60% BI	17" 53% BI	16" 31% BI	14" 36% BI	U.C.
5	Six Mile Point	O.W.	U.C.	10½" 100% SN	19" 95% SN	16" 69% BI	21" 64% BI	23" 74% BI	24½" 73% BI	26½" 79% BI	26" 80% BI	28" 79% BI	U.A.
6	Upper Lake Nicolet	U.C.	U.C.	6½" 100% SN	10" 75% BI	13" 85% BI	15" 82% BI	19½" 90% BI	18" 89% BI	19½" 87% BI	20½" 85% BI	19" 89% BI	20" 90% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1977-78
(Continued)

Sta.	Location	MAR 28, 78		APR 3, 78									
		O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
1	East Center Pier	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
2	Pittsburg Dock	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
5	Six Mile Point	21½" 77% BI	U.A.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
6	Upper Lake Nicolet	21½" 79% BI	19" 89% BI	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1976-77

Sta.	Location	13 DEC 76	22 DEC 76	27 DEC 76	3 JAN 77	10 JAN 77	17 JAN 77	25 JAN 77	1 FEB 77	8 FEB 77	14 FEB 77	22 FEB 77	28 FEB 77
1	East Center Pier	O.W.	O.W.	O.W.	O.W.	U.C.	13" 62% BI	14" 50% BI	16" 94% BI	21" 81% BI	21" 89% BI	17" 88% BI	22" 55% BI
2	Pittsburg Dock	O.W.	U.C.	U.C.	O.W.	9" 61% BI	9" 78% BI	U.A.	U.A.	U.C.	8" 50% BI	U.A.	U.A.
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	O.W.	U.C.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	U.C.	U.C.	O.W.	U.C.	14" 90% BI	16" 81% BI	15½" 77% BI	23" 62% BI	19" 66% BI	21" 60% BI	19" 63% BI	20" 55% BI
5	Six Mile Point	U.C.	7½" 87% BI	5" 100% SN	10" 60% BI	13" 75% BI	13" 54% BI	14½" 66% BI	11" 73% BI	18" 53% BI	15½" 55% BI	18½" 41% BI	17" 29% BI
6	Upper Lake Nicolet	6" 100% BI	6½" 85% BI	5" 20% BI	11" 73% BI	10½" 67% BI	14" 79% BI	14½" 66% BI	18" 80% BI	17" 65% BI	17" 68% BI	22" 41% BI	20½" 51% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1976-77
(Continued)

Sta.	Location	7 MAR 77	15 MAR 77	22 MAR 77	29 MAR 77															
1	East Center Pier	17" 41% BI	O.W.	O.W.	O.W.															
2	Pittsburg Dock	U.A.	O.W.	O.W.	O.W.															
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.															
4	Frechette Point	27" 37% BI	U.A.	O.W.	O.W.															
5	Six Mile Point	19½" 18% BI	6" 100% SN	U.A.	O.W.															
6	Upper Lake Nicolet	20½" 45% BI	12½" 44% BI	5" 100% SN	U.C.															

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES

WINTER 1975-76

Sta.	Location	15 JAN 76	22 JAN 76	29 JAN 76	6 FEB 76	13 FEB 76	19 FEB 76	27 FEB 76	4 MAR 76	11 MAR 76	18 MAR 76	26 MAR 76	2 APR 76
1	East Center Pier	O.W.	U.C.	U.C.	U.C.	U.C.	U.C.	O.W.	O.W.	U.C.	U.C.	O.W.	O.W.
2	Pittsburg Dock	O.W.	U.C.	U.C.	U.C.	U.C.	U.C.	O.W.	O.W.	U.C.	U.C.	O.W.	O.W.
3	Head of Little Rapids	O.W.	U.C.	U.C.	U.C.	U.C.	U.C.	U.C.	O.W.	U.C.	U.C.	O.W.	O.W.
4	Frechette Point		4" 100% BI	11" 91% BI	14½" 72% BI	15" 73% BI	15" 80% BI	16" 63% BI	16" 34% BI	19" 32% BI	20" 50% BI		O.W.
5	Six Mile Point		6½" 85% BI	9½" 68% BI	14" 71% BI	12" 83% BI	13" 85% BI	17" 53% BI	16" 47% BI	18" 67% BI	23" 52% BI	20" 55% BI	O.W.
6	Upper Lake Nicolet		9" 67% BI	11½" 74% BI	13½" 93% BI	15" 90% BI	16" 91% BI	16" 69% BI	21½" 65% BI	18" 72% BI	26" 42% BI	21" 67% BI	U.C.

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1974-75

Sta.	Location	23 JAN 75	30 JAN 75	6 FEB 75	13 FEB 75	20 FEB 75	27 FEB 75	6 MAR 75	13 MAR 75	20 MAR 75	27 MAR 75	3 APR 75	10 APR 75
1	East Center Pier	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
2	Pittsburg Dock	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	U.C.	U.C.	7.0" 29% BI	10.0" 55% BI	10.0" 50% BI	U.A.	U.A.	U.A.	U.A.	U.C.	U.C.	O.W.
5	Six Mile Point	U.C.	50% BI	4.0" 59% BI	8.5" 45% BI	9.0" 28% BI	12.5" 26% BI	11.5" 14% BI	14.5" 34% BI	12.0" 21% BI	10.0" 25% BI	9.5" 11% BI	6.5" 100% SN
6	Upper Lake Nicolet	3.0" 67% BI	9.0" 100% BI	9.5" 100% BI	11.0" 50% BI	15.0" 67% BI	17.5" 43% BI	17.0" 51% BI	19.5" 56% BI	19.0" 55% BI	18.5" 46% BI	19.0" 45% BI	19.5" 23% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES
WINTER 1973-74

Sta.	Location	3 JAN 74	10 JAN 74	17 JAN 74	24 JAN 74	1 FEB 74	7 FEB 74	14 FEB 74	28 FEB 74	14 MAR 74	21 MAR 74	28 MAR 74	4 APR 74
1	East Center Pier	O.W.	O.W.	O.W.	O.W.	U.C.	U.C.	10.5" 100% BI	13.0" 100% BI	O.W.	O.W.	O.W.	O.W.
2	Pittsburg Dock	O.W.	O.W.	O.W.	O.W.	U.C.	U.C.	11.5" 100% BI	11.0" 100% BI	U.C.	O.W.	O.W.	O.W.
3	Head of Little Rapids	O.W.	O.W.	O.W.	U.C.	O.W.	U.C.	9.0" 89% BI	9.5" 95% BI	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	U.C.	4.5" 82% BI	6.0" 33% BI	7.5" 33% BI	11.0" 27% BI	10.5" 19% BI	12.5" 32% BI	12.5" 40% BI	4.0" 10% BI	O.W.	O.W.	O.W.
5	Six Mile Point	U.C.	8.5" 100% BI	9.0" 100% BI	10.5" 71% BI	12.5" 60% BI	14.0" 79% BI	13.0" 62% BI	16.5" 70% BI	10.0" 20% BI	4.0" 100% SN	3.0" 100% SN	U.C.
6	Upper Lake Nicolet	U.C.	9.0" 100% BI	10.0" 100% BI	10.0" 80% BI	14.0" 75% BI	13.5" 78% BI	17.0" 74% BI	19.5" 69% BI	16.5" 73% BI	16.0" 50% BI	14.5" 79% BI	13.0" 77% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS
IN INCHES

WINTER 1972-73

Sta.	Location	9 JAN 73	16 JAN 73	23 JAN 73	30 JAN 73	6 FEB 73	13 FEB 73	21 FEB 73	27 FEB 73	6 MAR 73	14 MAR 73		
1	East Center Pier	O.W.	O.W.	O.W.	U.C.	O.W.	54" 100% BI	10½" 100% BI	9" 100% BI	11" 99% BI	O.W.		
2	Pittsburg Dock	U.C.	O.W.	O.W.	U.C.	U.C.	9" 87% BI	12" 85% BI	12½" 86% BI	11½" 58% BI	O.W.		
3	Head of Little Rapids	O.W.	O.W.	O.W.	O.W.	U.C.	8" 62% BI	10" 88% BI	9" 87% BI	U.C.	O.W.		
4	Frechette Point	U.C.	U.C.	U.C.	U.C.	U.C.	11½" 73% BI	12" 80% BI	11" 62% BI	U.C.	O.W.		
5	Six Mile Point	10" 75% BI	7½" 92% BI	9½" 88% BI	10½" 100% BI	14" 87% BI	13" 88% BI	15½" 73% BI	15½" 85% BI	15" 94% BI	U.C.		
6	Upper Lake Nicolet	10½" 100% BI	12½" 90% BI	11" 100% BI	12½" 100% BI	17" 96% BI	18½" 97% BI	19½" 100% BI	20½" 100% BI	18" 93% BI	U.C.		

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1971-1972

50

Sta.	Location	Date											
		21 JAN 72	28 JAN 72	4 FEB 72	11 FEB 72	17 FEB 72	25 FEB 72	6 MAR 72	13 MAR 72	20 MAR 72	27 MAR 72	4 APR 72	11 APR 72
1	East Center Pier	U.C.	U.C.	9" 67% BI	13" 86% BI	13" 82% BI	17½" 69% BI	15½" 76% BI	21½" 49% BI	18" 70% BI	19" 25% BI	U.A.	O.W.
2	Pittsburg Dock	U.C.	U.C.	8" 85% BI	10½" 72% BI	13½" 68% BI	14½" 67% BI	14" 63% BI	15" 64% BI	12" 64% BI	21" 34% BI	U.A.	O.W.
3	Head of Little Rapids	U.C.	U.C.		15" 52% BI	15" 44% BI	18" 52% BI	16½" 41% BI	17" 29% BI	11" 35% BI	U.A.	U.A.	O.W.
4	Frechette Point	U.C.	U.C.	12" 65% I	15½" 62% BI	14½" 77% BI	14½" 67% BI	18" 53% BI	15" 48% BI	13" 45% BI	20" 18% BI	U.A.	U.C.
5	Six Mile Point	U.C.	10½" 33% BI	9½" 38% BI	13" 64% BI	13½" 39% BI	16½" 41% BI	14½" 57% BI	23" 32% BI	13" 29% BI	13" 55% BI	12½"	22" 33% BI
6	Upper Lake Nicolet	8" 55% BI	7½" 100% BI	9" 47% BI	14" 84% BI	13" 64% BI	18½" 80% BI	18" 81% BI	17" 79% BI	13½" 76% BI	17" 43% BI	18½"	19" 38% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1970-71

Sta.	Location	22 JAN 71	29 JAN 71	4 FEB 71	12 FEB 71	18 FEB 71	25 FEB 71	4 MAR 71	11 MAR 71	18 MAR 71	24 MAR 71	1 APR 71	9 APR 71
1	East Center Pier	O.W.	U.C.	U.C.	12" 85% BI	13" 68% BI	14½" 67% BI	17" 50% BI	17½" 48% BI	18" 50% BI	19½" 57% BI	19" 50% BI	O.W.
2	Pittsburg Dock	O.W.	U.C.	10" 52% BI	12½" 57% BI	14" 48% BI	17" 54% BI	18" 33% BI	16" 33% BI	15" 20% BI	14" 22% BI	13" 23% BI	O.W.
3	Head of Little Rapids	O.W.	U.C.	O.W.	U.C.	U.C.	U.C.	U.C.	U.C.	O.W.	O.W.	O.W.	O.W.
4	Frechette Point	U.C.	U.C.	16" 85% BI	18" 87% BI	20½" 75% BI	21" 74% BI	20½" 59% BI	18½" 48% BI	18" 33% BI	17½" 31% BI	7"	O.W.
5	Six Mile Point	11½" 84% BI	15½" 65% BI	16" 74% BI	16" 77% BI	20½" 65% BI	20" 58% BI	21" 66% BI	21½" 67% BI	23" 53% BI	23" 53% BI	19" 44% BI	U.C.
6	Upper Lake Nicolet	10½" 81% BI	18½" 82% BI	18½" 82% BI	17½" 86% BI	19" 75% PI	21½" 67% BI	21½" 50% BI	23" 61% BI	23" 53% BI	20" 45% BI	24" 60% BI	20" 55% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1969-70

Sta.	Location	15 JAN 70	22 JAN 70	29 JAN 70	5 FEB 70	12 FEB 70	19 FEB 70	26 FEB 70	5 MAR 70	12 MAR 70	19 MAR 70
1	East Center Pier	4" 100% SN	8" 100% BI	9½" 100% BI	14" 78% BI	14" 65% BI	14½" 71% BI	15½" 73% BI	16" 63% BI	17" 100% BI	O.W. O.W.
2	Pittsburg Dock	U.C.	7" 100% BI	6½" 100% BI	11½" 58% BI	8" 54% BI	11" 69% BI	9½" 50% BI	2½" 50% BI	5" 100% SN	O.W. O.W.
3	Head of Little Rapids	U.C.	U.C.	U.C.	10" 41% BI	U.C.	11" 69% BI	12" 70% BI	O.W.	O.W.	O.V.
4	Frechette Point	U.C.	6" 100% BI	6" 80% BI	9½" 50% BI	11" 56% BI	6½" 27% BI	6½" 27% BI	O.W.	O.W.	O.W.
5	Six Mile Point	U.C.	9½" 100% BI	6½" 100% BI	14½" 58% BI	14½" 58% BI	15½" 62% BI	11" 63% BI	12" 40% BI	9" 13% BI	6½" 100% BI
6	Upper Lake Nicolet	6" 100% BI	11" 100% BI	10" 65% BI	16" 70% BI	14½" 54% BI	13" 55% BI	12½" 43% BI	17" 57% BI	13" 36% BI	14½" 29% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1968-69

Sta.	Location	20 JAN 69	27 JAN 69	3 FEB 69	10 FEB 69	12 FEB 69	14 FEB 69	17 FEB 69	19 FEB 69	24 FEB 69	26 FEB 69	28 FEB 69	3 MAR 69
1	East Center Pier	7½" 90% SN	10" 50% SN	11½" 40% SN	14½" 10% SN	14½" 84% BI	14½" 83% BI	15" 81% BI	14½" 74% BI	15½" 85% BI	15½" 84% BI	15½" 85% BI	15½" 78% BI
2	Pittsburg Dock	3½" 100% SN	5½" 75% SN	8½" 100% SN	11½" 75% BI	12" 80% BI	12" 82% BI	13½" 80% BI	13½" 80% FI	13" 73% BI	13" 74% BI	12½" 76% BI	14" 78% BI
3	Head of Little Rapids	O.W.	O.W.	U.C.	11" 100% BI	11" 100% BI	12" 100% BI	13" 100% BI	12" 100% BI	U.C.	U.C.	U.C.	U.C.
4	Frechette Point	3½" 100% SN	10" 50% SN	12½" 75% SN	16½" 71% BI	18" 74% BI	14" 68% BI	15½" 69% BI	16" 67% BI	13½" 63% BI	12" 60% BI	12" 60% BI	12" 60% BI
5	Six Mile Point	8" 100% BI	10½" 100% BI	11½" 90% BI	14" 87% BI	13" 86% BI	14" 86% BI	15" 87% BI	14½" 83% BI	15" 73% BI	15" 73% BI	14" 78% BI	13" 75% BI
6	Upper Lake Nicolet	7" 100% BI	9½" 75% BI	12" 80% BI	13" 82% BI	13½" 82% BI	15" 87% BI	16" 89% BI	16½" 87% BI	16" 83% BI	17" 85% BI	16" 89% BI	16" 89% BI

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI =Blue Ice; SN = Snow Ice.

ST. MARYS RIVER ICE THICKNESS IN INCHES

WINTER 1968-69
(Continued)

Sta.	Location	5 MAR 69	7 MAR 69	10 MAR 69	12 MAR 69	14 MAR 69	17 MAR 69	20 MAR 69	24 MAR 69	27 MAR 69		
1	East Center Pier	14½" 74% BI	16" 76% BI	16" 83% BI	17½" 85% BI	16½" 79% BI	17" 79% BI	15" 100% SN	O.W.	O.W.		
2	Pittsburg Dock	12" 71% BI	13" 75% BI	11" 54% BI	12½" 57% BI	12" 59% BI	9" 65% BI	O.W.	O.W.	O.W.		
3	Head of Little Rapids	U.C.	U.C.	U.C.	U.C.	O.W.	O.W.	O.W.	O.W.	O.W.		
4	Frechette Point	12" 59% BI	11½" 53% BI	9" 52% BI	10" 47% BI	8" 75% BI	7½" 66% BI	U.C.	O.W.	O.W.		
5	Six Mile Point	13" 73% BI	12½" 67% BI	13½" 71% BI	14" 76% BI	12" 69% BI	12" 88% BI	7½" 100% SN	O.W.	O.W.		
6	Upper Lake Nicolet	16" 80% BI	17" 79% BI	16½" 80% BI	17" 78% BI	16½" 80% BI	17" 79% BI	14" 68% BI	13½" 100% SN	11" 100% SN		

Legend: O.W. = Open Water; U.C. = Unsafe Cover; U.A. = Unsafe Access; BI = Blue Ice; SN = Snow Ice.